REMARKS

Applicant would like to thank the Examiner for the careful consideration given the present application. The application has been carefully reviewed in light of the Office action, and amended as necessary to more clearly and particularly describe the subject matter which applicant regards as the invention.

Initially, Applicant would like to thank the Examiner for speaking with the undersigned attorney on August 31, 2010 to discuss the present application and the cited prior art. Applicant has slightly amended claim 1 as suggested by the Examiner to further clarify matters as will be discussed hereinafter. This amendment does not alter the scope of the claims, does not raise new issues, and does not require further search by the Examiner. As such, it is respectfully submitted that this amendment should be entered and the application should be allowed in its current form.

The Examiner has rejected claims 1-7 under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. Pub. No. 2003/0018283 to Dariush in view of U.S. Pat. No. 6,289,265 to Takenaka. The Examiner's rejections are traversed for the following reasons.

The present application relates to a method of estimating a joint moment of a bipedal walking body. The method includes a first step for sequentially grasping the displacement amounts of a plurality of joints, including at least an ankle joint, a hip joint and a knee joint of each leg of a bipedal walking body, and a second step for sequentially grasping the positions and/or postures of corresponding rigid bodies of the bipedal walking body that are associated with rigid elements of a rigid link model

using at least the rigid link model. The rigid link model is established beforehand to express the bipedal walking body in the form of a link assembly composed of a plurality of the rigid elements and a plurality of joint elements and the grasped displacement amounts of the joints. The method further includes a third step for grasping the acceleration of a preset reference point of the bipedal walking body by using at least an output of an acceleration sensor attached to a predetermined region of the bipedal walking body, and a fourth step for sequentially grasping a floor reaction force acting on each leg and the position of an acting point of the floor reaction force. The grasped positions and/or the postures of the corresponding rigid bodies of the bipedal walking body, the floor reaction force and the position of the acting point of the floor reaction force being changeable every moment, the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force are used to estimate a joint moment acting on at least one joint of each leg. At least the displacement amounts of the hip joint, the knee joint, and the ankle joint of each leg that are grasped in the first step include the amount of rotation about an axis substantially perpendicular to a leg plane as a plane passing through these three joints. The method also includes the steps of fixedly setting a posture of a leg coordinate system to the leg plane, changing the posture of the leg coordinate system with respect to a body coordinate system that is fixedly set to the bipedal walking body, and measuring the hip joint displacement amount about three axes including an axis perpendicular to the leg plane. The displacement amount of the hip joint is a three-dimensional amount, and the positions and/or postures of the corresponding rigid bodies grasped in the second step include at least the positions and/or the postures of the corresponding rigid

bodies of the leg on the leg plane, the acceleration of the reference point grasped in the third step and the floor reaction force and the position of the acting point of the floor reaction force grasped in the fourth step are three-dimensional amounts. A component of a joint moment acting on at least one joint of the leg about the axis that is substantially perpendicular to the leg plane is estimated on the basis of an inverse dynamic model representing the relationship between the motions of the corresponding rigid bodies of the leg and the translational forces and the moments acting on the corresponding rigid bodies on the leg plane by using the two-dimensional amounts obtained by projecting at least the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force onto a leg plane related to the leg on the basis of a displacement amount of the hip joint of the leg, and the positions and/or the postures of the corresponding rigid bodies of the leg on the leg plane.

Dariush relates to a feedback estimation of joint forces and joint moments. In particular, Dariush includes an upper body portion 105 and a lower body portion 110. The lower body portion 110 includes an ankle joint 120, a knee joint 125, and a hip joint 130. A "forward dynamics module determines kinematics through numerical integration (or simulation) of the dynamic equations of motion" (*Para. [0011]*). Further, "joint loads are recursively estimated for a planar serial link system" (*Para. [0012]*).

Takenaka involves a controller for a legged mobile robot. In particular, Takenaka relates "to a posture control system of a legged mobile robot, and more specifically a system for conducting a compliance control on the motion of the legs of a legged mobile robot, in particular a biped robot, and controls the floor reaction

force acting on the robot appropriately" (*Col. 1, lines 7-12*).

Claim 1 of the present application recites that "at least the displacement amounts of the hip joint, the knee joint, and the ankle joint of each leg that are grasped in the first step include the amount of rotation about an axis substantially perpendicular to a leg plane as a plane passing through these three joints, a posture of a leg coordinate system which is fixedly set to the leg plane is changeable with respect to a body coordinate system which is fixedly set to the bipedal walking body". Claim 1 has been amended to also recite the steps of "fixedly setting a posture of a leg coordinate system to the leg plane; changing the posture of the leg coordinate system with respect to a body coordinate system that is fixedly set to the bipedal walking body; and measuring the hip joint displacement amount about three axes including an axis perpendicular to the leg plane".

In the final Office action, the Examiner notes that "Dariush teaches finding rotational displacement of each of the ankle, knee and hip all in the same plane the x-y plane of the page about an axis substantially perpendicular, or the z-axis coming out of the page as theta_1, theta_2 and theta_n in Figure 2 and 7" (*Pg. 6, Sect. 5*). However, Figs. 2 and 7 of Dariush are free body diagrams (Paras. [0018, 0023]. As would be known to one skilled in the art, a free body diagram is a pictorial representation to analyze the forces acting on a body of interest, not a layout of the bodies. Claim 1 requires that a plane pass through the joints, not that a pictorial representation of the forces felt by the bodies be reduced to a 2-D illustration. The free body diagrams merely show the forces felt by the bodies reduced to the X-Y plane. While the free body diagrams may be shown in an X-Y plane, no plane ***passes through*** all of the joints as required by claim 1 of the present application.

Accordingly, removal of the rejection of claim 1, and claims 2-7 that depend therefrom is respectfully requested.

Claim 1 of the present application further recites that

> "a component of a joint moment acting on at least one joint of the leg about the axis that is substantially perpendicular to the leg plane is estimated on the basis of an inverse dynamic model representing the relationship between the motions of the corresponding rigid bodies of the leg and the translational forces and the moments acting on the corresponding rigid bodies on the leg plane by using the two-dimensional amounts obtained by projecting at least the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force onto a leg plane related to the leg on the basis of a displacement amount of the hip joint of the leg, and the positions and/or the postures of the corresponding rigid bodies of the leg on the leg plane".

Examination of Dariush fails to teach or suggest estimating a moment based upon motion of the corresponding rigid body. Dariush uses a recursive process that estimates moment based upon the force and moment of the preceding rigid body, not the motion of the body. For example, Dariush teaches that "one computes the forces and moment acting on second joint 222 in terms of the forces and moment acting on first joint 220" (*Para. [0048]*). For this further reason, the rejection of claim 1, and claims 2-7 that depend therefrom, should be removed.

In light of the foregoing, it is respectfully submitted that the present application is in a condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in a condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. SAT-16451.

Respectfully submitted,

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